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On two cercariae of the genus *Tylodelphys* Dies.:

T. excavata (Rud.) and *T. clavata* (Nord.)

Diplostomatidae

O dwu cercariach z rodzaju *Tylodelphys* Dies.: *T. excavata* (Rud.) i *T. clavata* (Nord). — *Diplostomatidae*

During studies on the cercariae of Lake Arklity (Northeastern Poland) in 1958—1959 the author found two cercariae morphologically closely resembling one another. One of them, occurring in *Coretus corneus* (L.) is a cercaria of *Tylodelphys excavata* (Rud. 1803) Szidat, 1935, while the other, developing in *Radix ovata* Drap., was identified as *Cercaria letifera* Fuhrm., 1916.

Cercaria of *T. excavata* is known from a drawing and description presented by Szidat, 1935. Szidat found a cercaria of *T. excavata* in natural infestation in *Coretus corneus* L., and followed experimentally the development of this larva from egg to a sexually mature form. The life cycle was described very superficially. No detailed description of cercaria and other developmental stages was given. Zdun, 1959, listed the cercaria of *T. excavata* among cercariae occurring in *C. corneus* in the vicinity of Warszawa, and gave a short relation of its anatomy and measurements. The present paper contains a description of the cercaria based on the author's own observations.

Cercaria Tylodelphys excavata (Rudolphi, 1803)

Szidat, 1935

The cercariae develops in long, thread like sporocysts up to 4 mm long and 0.09 mm wide. The posterior part of the sporocyst is rounded while the anterior is slightly conical. Birth pore is situated

subterminally (Fig. 1). The sporocyst is filled with cercariae at various stages of development.

The cercaria is large and highly mobile. The anterior segment of its body (up to the ventral sucker) stretches strongly and narrows down several times (Fig. 2a). It can also bend to form a cane. The highly developed ventral sucker is situated posteriorly to the center

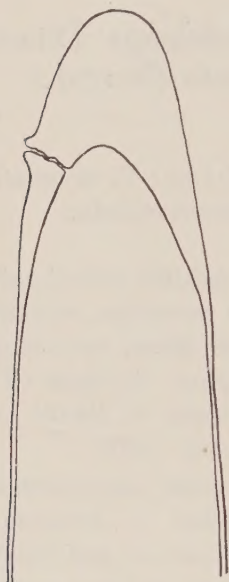


Fig. 1. Fore part of a sporocyst of *Tyloodelphys excavata* (Rud.)

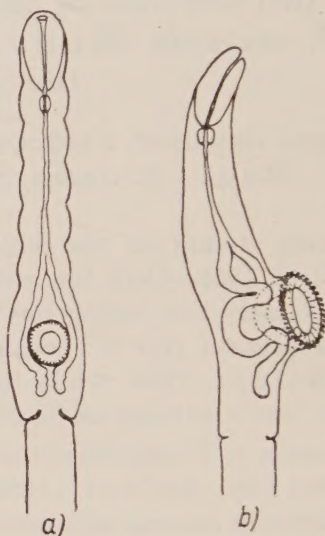


Fig. 2. Cercaria of *T. excavata* (Rud.) — infravital sketches

of the body. It may protract and retract changing simultaneously its size. At the outer margin of the sucker there is a wreath of large hooks. The number of hooks varies from 35 to 40. The anterior organ is oval. The anterior part may invaginate to the inside. Above the oral cavity there are two rows of fairly large spines. The lower row is made up of 5 spines, the upper one of 8. The anterior part of the body behind the oral cavity is covered with minute spines forming a chess-board. The size of spines decreases toward the posterior. The spines extend to about half the anterior organ. The digestive tract is well developed. Behind the anterior organ there is a fairly pronounced pharynx. The esophagus, widening at

the pharynx and narrowed down toward the posterior, reaches half length between the anterior organ and the ventral sucker where it bifurcates. The caeca are long and narrow forming turns in the frontal and sagittal planes (Fig. 2b). Above the ventral sucker they first part and then approach one another and the ventral surface of the body. Then they part again surrounding the ventral sucker and pass toward the posterior side. Posteriorly to the ventral sucker they again approach one another and the ventral surface of the body, forming lateral loops and end in front of the excretory vesicle. There are four large penetration glands, with irregular edges. They are situated anteriorly to the ventral sucker at the point of bifurcation of the intestine. The two anterior ones lie dorsally and ventrally, two posterior ones along one another (right and left). The posterior pair of glands moves over to the outer sides of the intestine during contractions of the cercarial body. The ducts of the penetration glands run along the esophagus, two on each side of the body, cross the anterior organ and find their outlets beside the oral cavity (Fig. 3).

The tail of the cercaria is nearly as long as the body of a resting cercaria. Inside it, among a band of cells, runs the caudal excretory canal. No tail bodies were observed. Tail musculature clearly visible. Furca nearly as long as the tail.

Table I

in mm	Live		Killed by heat
	stretched	contracted	
body length	0.225	0.114	0.210
body width	0.029	0.049	0.042
length of tail	0.190 — 0.198		0.195
width of tail	0.026		0.029
length of furca	0.171 — 0.198		0.218
width of furca			0.015
anterior organ	0.040 × 0.028		0.047 × 0.025
pharynx (length)	0.010		
ventral sucker	0.036 × 0.036		0.037 × 0.040

The excretory system is very difficult to observe. The cercariae are highly mobile, and quickly perish when squashed a little

stronger. Observations are furthermore made difficult by the intestinal folds. The excretory vesicle is located at the posterior end of the body. From it emerge two main collecting canals surrounding the intestine from behind and running along its outer side toward the anterior. At the level of the ventral sucker they separate into the anterior and posterior collective canal. The anterior collective canal receives the capillaries of five flame cells, while the posterior one of six. Two posterior flame cells are located in the tail. Unfortunately, due to difficulties in observation of flame cells, the connections between them were not established. The main caudal canal departs from the excretory vesicle toward the posterior, dividing at the end of the tail into two canals, penetrating the furca and making their way out at half the length of the furca. No Cort's island was observed.

Host: *Coretus corneus* (L.)

Cercaria of *T. excavata* shows a definite specificity in regard to this snail species. During studies on cercariae of Lake Gołdapiwo, Mamry Północne and Arklity of the Mazury lakeland, 6678 snail specimens belonging to the following species were examined: *Lymnaea stagnalis* L., *Stagnicola palustris* Müll., *Radix auricularia* (L.), *Radix ovata* Drap., *Myxas glutinosa* Müll., *Physa fontinalis* (L.), *Coretus corneus* (L.), *Planorbis planorbis* (L.), *Planorbis carinatus* Müll., *Spiralina vortex* (L.), *Batyomphalus contortus* L., *Segmentina nitida* Müll., *Bithynia tentaculata* (L.), *Viviparus viviparus* (L.), *Viviparus fasciatus* (Müll.) and *Theodoxus fluviatilis* (L.). The cercariae of *T. excavata* were found only in *Coretus corneus* (L.). The extensiveness of invasion of *C. corneus* with cercariae of *T. clavata* in large bodies of water is comparatively low. Out of 212 *C. corneus* examined in Lake Arklity only 4 were infested. In Lake Gołdapiwo and Mamry Północne 5 out of 320 examined specimens of *C. corneus* were infested.

In order to ascertain that the cercaria found by the author is the larval form of *T. excavata*, tadpoles of *Rana esculenta* L. and *Bombina variegata* L., reared from eggs in the laboratory, were infected with it. The cercariae penetrated, travelled to the vertebral canal and there transformed into *Tylodelphys rhachiaea* Henle, which as shown by Ciurea (1928) and Szidat (1935) is the metacercaria of *Tylodelphys excavata* (Rudolphi, 1803) Szidat 1935. A similar result was obtained by infecting mature *Rana*



Fig. 3. Cercaria of *Tylodelphys excavata* (Rud.)

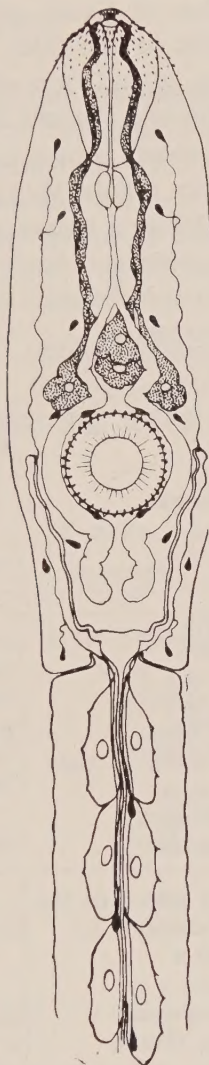


Fig. 4. Cercaria *letifera* Fuhrm. = cercaria of *Tylodelphys clavata* (Nord.)

esculenta L. with this cercaria. Attempts at infecting fish with this cercaria yielded negative results.

Comparison of Szidat's drawing with the author's observations showed differences in structure of the excretory system, namely in

the number of flame cells observed. Szidat observed 5 pairs of flame cells in the body of the cercaria and 2 pairs in the tail. According to author's observation the body contained 9 pairs of flame cells and the tail 2.

The cercaria drawn by Szidat (1935) bears great resemblance to *Cercaria tenuis* Miller 1923. Dubois (1944) supposes that possibly *Cercaria tenuis* is the larval form of *Tylodelphys excavata*. The two cercariae, however, differ in some respects. The table II presents measurements and more important anatomical features of the two cercariae.

Table II

in mm.	<i>Cercaria tenuis</i> Mill. 1923 (acc. to Miller, 1926)		<i>Cercaria T. excavata</i>	
	live	mounted in Canada balsam	live	killed by heat
body length	0.288	0.225	0.225 0.114	0.210
body width		0.021	0.029 0.049	0.042
length of tail	0.240	0.216	0.190 — 0.198	0.195
width of tail		0.021	0.026	0.029
length of furca	0.240	0.207	0.171 — 0.198	0.218
width of furca at base				0.015
anterior organ		0.045 (length)	0.040 × 0.028	0.047 × 0.020
pharynx (length)	0.011	0.008	0.010	
ventral sucker	0.025		0.036 × 0.036	0.037 × 0.04
number of spines on the ventral sucker	22		35 — 40	
caudal bodies	5 pairs		numerous minute cells along the caudal canal	
excretory system	$2 \times [(2) + (3 + [2])] = 14$		$2 \times [(5) + (4 + [2])] = 22$	
penetrating glands	4 (anterior, dorsal and ventral and posterior, lateral ones)		4 (anterior, dorsal and ventral and posterior, lateral ones)	
host	<i>Planorbis trivolvis</i>		<i>Coretus corneus</i>	

The measurements of the body of cercariae are similar. Differences concern size of ventral sucker (smaller than in *C. tenuis*) and number of spines on it (only 22 in *C. tenuis*). *C. tenuis* has less flame cells and a different intermediate host. The differences seem to speak in favour of two separate species.

Cercaria letifera Fuhrmann, 1916

Found in Lake Arkhity in *Radix ovata* Drap. The extensiveness of infestation of snails with *C. letifera* is in this lake very slight. 227 specimens of *Radix ovata* were examined and 6 were found invaded. In other Mazury Lakes (Goldapiwo and Mamry Pólnocne) *C. letifera* was also found only in this snail species. Fuhrmann (1916), Dubois (1929) and Wesenberg — Lund (1923) name *Radix auricularia* the host of *C. letifera*.

The morphology and measurements of *C. letifera* collected by the author correspond to those given by Dubois (1929) and Fuhrmann (1916). They are illustrated in Fig. 4 and table III.

Table III

in mm.	Fuhrmann 1916	Dubois 1929	Author's measurements	
			stretched out	contracted
body length	0.200 — 0.260	0.150 — 0.270	0.240 — 0.266	0.120 — 0.133
body width	0.044 — 0.056	0.040 — 0.050	0.024	0.040
length of tail	0.180 — 0.200	5.170 — 0.210	0.160 — 0.190	
length of furca	0.160 — 0.200	0.200 — 0.240	0.160	
anterior organ	0.053×0.023	$0.046 - 0.055 \times$ $0.020 - 0.030$	0.040×0.024	
pharynx (length)	0.028	0.012	0.010	
ventral sucker	0.027	0.024 — 0.030	0.035 — 0.040	
spines on the ventral sucker		35 — 40	35 — 40	
penetration glands	4 above vent- ral sucker	4 above ventral sucker	4 above ventral sucker	
caudal bodies	5 pairs	5 pairs	5 pairs	
excretory system		$2 \times [(4) + (2 + [2])]$ = 16	$2 \times [(5) + (4 + [2])] = 22$	

Differences were observed only in the structure of the excretory system. The number of flame cells was greater than given by Dubois (1929) and Wesenberg-Lund (1934). The anterior collective canal collects the capillaries of 5 flame cells, the posterior one of 6 (the two marginal flame cells are situated in tail).

Cercaria letifera Fuhrm., 1916 bears great morphological resemblance to cercaria of *Tylodelphys excavata* (Rud.).

This similarity suggested to the author that *Cercaria letifera* is also the larval form of a worm belonging to the genus *Tylodelphys*



Dies. Metacercaria of *Tylodelphys clavata* (Nordmann 1832) Diesing 1850 parasitizing the eyes of fish is very common in the Mazury lakeland. An experiment was therefore set up to ascertain whether it does not develop from *Cercaria letifera*. Three species of fish were infested: *Perca fluviatilis* (L.), *Rutilus rutilus* (L.) and *Carassius carassius* (L.). Young, one year old fish were placed in a large aquarium filled with large volume of water together with a snail, *Radix ovata*, emitting cercariae *C. letifera*. All the three species of fish were subjected to experiment concurrently. They were examined after three hours. Freshly penetrated metacercariae were found in the eyes of *P. fluviatilis* and *R. rutilus* and some also migrating through muscles toward the head. *C. carassius* was negative in this experiment.

Fig. 5. Metacercaria of *T. clavata* (Nord.) 24 h after infestation

When the experiment was repeated with a smaller volume of water about 3 cm deep, *C. carassius* did become infected. The initial negative result was probably due to lack of contact between the fish holding to the bottom and cercariae floating upward and nearer to the surface.

Very young metacercariae, 24 hours after penetration are identical with the cercariae in both measurements and structure. Only the penetrating glands have undergone changes appearing in the form of hardly visible granules. The distal parts of the ducts of penetration glands persist. The armature of the anterior segment of the body and the ventral sucker remains unchanged (Fig. 5).

Further development of the metacercaria did not differ from the development of metacercaria *T. clavata* observed in natural infestation by Kozicka et Niewiadomska (1960).

Giniecinskaja (1959) reared from eggs a cercaria of *Tylodelphys conifera* (Mehlis 1864) Dubois 1937 in experimental hosts,

Planorbis vortex and *Anisus contortus*. Kozicka et Niewiadomska (1960) showed that *T. conifera* (Mehl.) occurring in *Podiceps cristatus* (L.), *P. griseigena* (Bodd.) and *P. nigricollis* Brehm develops from the metacercaria *T. clavata* (Nordmann 1832) Diesing 1850, parasitising fish eyes. The cercaria obtained essentially by Ginecinskaja is the cercaria of *Tylodelphys clavata* (Nord.) and is, therefore, identical with *Cercaria letifera* Fuhrm. There are certain differences between the description furnished by Ginecinskaja and the author's observations. They concern the number of hooks on the ventral sucker (Ginecinskaja mentions only 27—30). The number of flame cells although greater than given by Dubois (1929) and Wesenberg-Lund (1934) ($2 \times [(4) + (2 + [2])] = 16$) is smaller than observed by the author. The excretory formula given by Ginecinskaja is $2 \times [(2 + 2) + (2 + 1 + [2])] = 18$. In my findings there are four flame cells more between the intestine and the ventral sucker, two above and two below the sucker. The differences in dimensions are slight.

Tabela IV

in mm.	<i>Tylodelphys conifera</i> (according to Ginecinskaja 1959)	<i>C. letifera</i> = <i>T. clavata</i> (Nord.) collected by the author	
		stretched out	contracted
body length	0.225 — 0.920	0.240 — 0.266	0.120 — 0.133
body width	0.0475	0.024	0.040
length of tail	0.100 — 0.275	0.168 — 0.190	
width of tail	0.037 — 0.040		
length of furca	0.225 — 0.200	0.160	
anterior organ	0.034 — 0.062 $\times$ 0.034 — 0.032	0.040 $\times$ 0.024	
pharynx	0.0085	0.010	
esophagus	0.0375		
ventral sucker	0.0275 — 0.0289	0.024 — 0.028	

The upper limit of cercaria's length given by Ginecinskaja is probably a printer's error. The author does not mention whether the limits correspond to the maximum contraction and maximum stretching of the body, but even in such a case the given value seems improbable especially since 0.225 corresponds to the value of stretched specimens given by other authors (Fuhrmann 1916, Dubois 1929).

Conclusions

(1) Comparison of cercaria *T. excavata* (Rud.) Szid. with *Cercaria tenuis* Miller 1923 shows them to be separate species.

(2) *Cercaria letifera* Fuhrmann 1916 was experimentally proved to be the larval form of *Tylodelphys clavata* (Nordmann 1832) Diesing 1850.

(3) *Cercaria Tylodelphys conifera* (Mehlis 1864) Dubois 1937 described by Ginecinskaja (1959) is considered on the basis of work of Kozicka et Niewiadomska (1960) to be identical with *C. letifera* Fuhrmann 1916 = *Tylodelphys clavata* (Nordmann 1832) Diesing 1850.

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STRESZCZENIE

Autorka podaje dokładny opis cercarii *Tylodelphys excavata* (R u d.). Na podstawie porównania cercarii *T. excavata* (R u d.) z *Cercaria tenuis* Mill., autorka uznaje te gatunki za odrębne.

Na podstawie badań eksperymentalnych autorka stwierdza, że *Cercaria letifera* F u h r m. jest formą larwalną *Tylodelphys clavata* (N o r d.).

W oparciu o badania Kozickiej i Niewiadomskiej (1960) autorka stwierdza, że opisana przez Ginecińską (1959) cercaria *Tylodelphys conifera* (M e h l.) jest identyczna z *Cercaria letifera* F u h r m., czyli z *T. clavata* (N o r d.).

